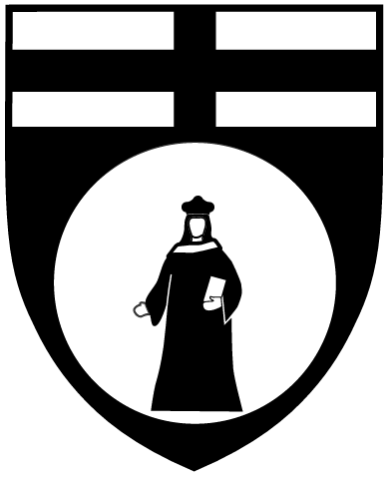

Dibris Dipartimento di Informatica, Bioingegneria,
Robotica e Ingegneria dei Sistemi

Virtual Reality For Robotics

Project Report

Photogrammetry & 3D Model Reconstruction

Advisor: Prof. Gianni Viardo Vercelli

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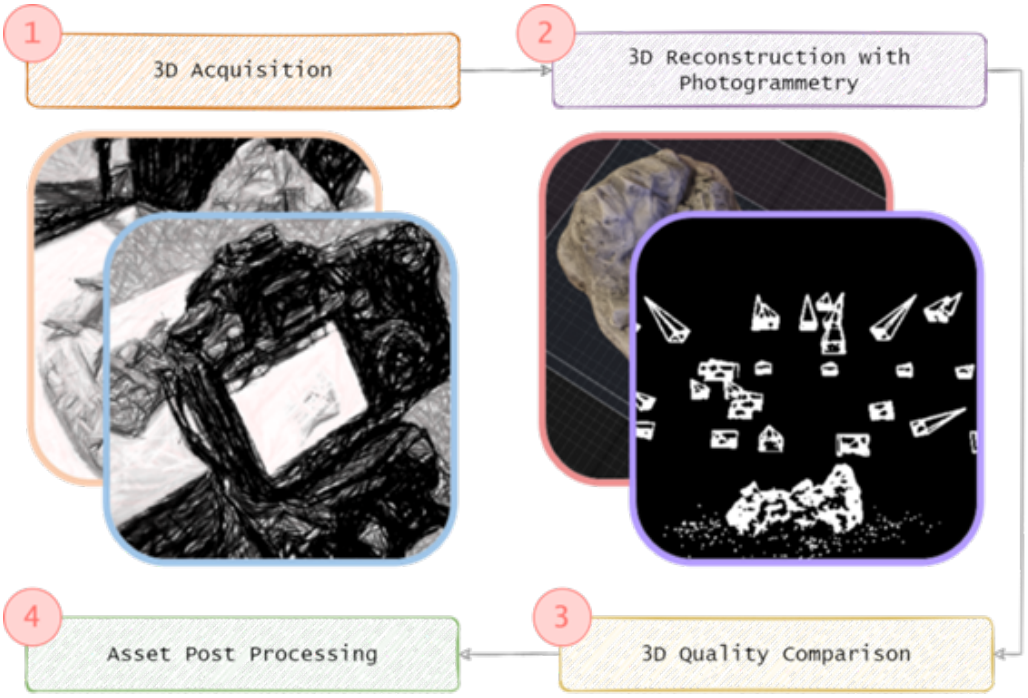
Contents

1 Introduction

In the past three decades, Virtual reality (VR) has been evolving at a rapid pace, allowing for the creation of worlds that replicate the actual world and the creation of interactions and visualizations that would otherwise be impossible. Virtual environments for cultural heritage diffusion and virtual experimentation were created by integrating 3D image acquisition techniques such as digital photogrammetry (captured reality) with computer 3D modelling.
Many sophisticated applications now demand three-dimensional 3D data. The challenge of efficiently and precisely constructing real-time 3D representations of a scene has applications in various computer vision domains, including robotics, augmented and virtual reality, 3D image processing, 3D visualization and entertainment. [5]
At present, the computer vision scientific community has developed novel reconstruction methods that employ various types of equipment. In the examination of dynamic or static settings, the third dimension is critical. Surveillance and robotic domains that use depth information to acquire a much better understanding of the environment are examples of fields of use in everyday life that may leverage the third dimension.
Existing 3D modelling methods may be classified based on the needed input data and their efficacy is measured by the number of scenes that can be processed, the quality of the final model, and the overall processing time. Depending on the user's needs, automated, semi-automatic, or manual image-based methodologies can be used to generate digital models suitable for inspections, visualization, or documentation. Automated approaches focus primarily on process automation, although the outputs are often enough for nice-looking real-time 3D recording or basic visualization. Semi-automated solutions, on the other hand, attempt to strike a compromise between precision and automation and are extremely valuable for detailed documentation and restoration planning. [6]
Laser scanning technology has evolved as an effective and competitive option for making 3D reconstructions in recent years. The primary benefits of using this technology are (i) speed, (ii) accuracy, and (iii) reconstruction resolution. Furthermore, the scanners' field of vision enables the reconstruction of objects ranging in size from a few centimetres to several meters and existing across a short or long distance. As a result, this technique is appropriate for large-scale sceneries such as the interior and exterior of buildings, and it is widely regarded by the community as a viable support for the documenting and protection of historic structures, monuments, or archaeological sites. [7] The following phases are required for epigrammatically reconstructing a scenario:

1. Acquiring enough colour range scans to adequately cover the 3D scene
2. 3D Reconstruction with Photogrammetry
3. 3D Quality Comparison
4. Data processing for final 3D surface model refining



: 3D model Reconstruction Phases [3]

3D Data Acquisition: 3D data acquisition refers to the process of capturing information about the three-dimensional shape, surface, and/or appearance of an object or scene using specialized equipment or techniques. This can be done using a variety of methods, such as structured light, laser scanning, photogrammetry, and computer vision, among others. The captured data can then be used for a variety of purposes, such as computer graphics, scientific visualization, measurement, and inspection.

3D Data Processing: 3D data processing refers to the process of using computer software to analyze and manipulate 3D data captured by a reality capture device, such as a laser scanner or photogrammetry camera. This can include tasks such as cleaning and filtering the data, aligning and merging multiple scans or images, and creating a 3D model or point cloud of the captured environment. The resulting 3D data can be used for a variety of purposes, including building and construction, asset management, heritage preservation, and more.

2 State of Art

Photogrammetry is a technique for creating three-dimensional models and maps from two-dimensional images. It involves taking a series of photographs from different angles and using specialized software such as Capture Reality [1] and Unreal Engine [2] to process the images and generate a 3D model or map. [3]
One of the key challenges in photogrammetry is accurately aligning the images, which is known as image registration. This can be difficult due to factors such as variations in lighting, camera position, and image distortion. To address these challenges, researchers have developed techniques such as feature-based alignment and structure-from-motion.
Another important aspect of photogrammetry is the creation of accurate and detailed 3D models. This can be achieved through the use of techniques such as multi-view stereo, which involves comparing multiple images of the same scene to generate a 3D point cloud. Other techniques, such as lidar and structured light, can also be used to create high-resolution 3D models. [4]
Recent advances in machine learning have also led to the development of neural network-based methods for photogrammetry. These methods can learn to align images and create 3D models from large datasets, and have the potential to significantly improve the accuracy and speed of photogrammetry.
Overall, photogrammetry and 3D model reconstruction are active areas of research with numerous practical applications, including mapping, architectural documentation, and heritage preservation.

3 Tools

Here is the list of tools that we encounter to fulfil the requirements of our project along with the GitHub repository.

1. Capture Reality 1.2.1 [1]
2. Unreal Engine 5 [2]
3. GitHub Project

4 Description

The implementation of our project is based on the mentioned software tools. The project methodology will be further discussed when the work is done.

5 Results

Results will be written after completing the project.

6 Conclusions

Overall, photogrammetry and 3D model reconstruction are active areas of research with numerous practical applications, including mapping, architectural documentation, and heritage preservation.

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